***Original Research Article***

# Seasonal incidence of insect pests andpredatory fauna on toria in west centraltableland of Odisha.

.


## ABSTRACT

The present field investigation was conducted for two consecutive *Rabi*seasonsof years 2021/22 and 2022/23at the College of Horticulture, Odisha University of Agriculture and Technology, Chiplima, Odisha to record the seasonal incidence of major insect pests with the predatory fauna on toria (*Brassica rapa*) in relation to meteorological parameters.The occurring pest complex in both seasons constituted a total nine number of insects and three consistent predatory fauna.

The highest peak population of pests recorded for 2021/22were: mustard aphid (3.7 A.Iplant$^{-1}$ at 50$^{th}$ SMW), whitefly (25.9 whiteflies plant$^{-1}$ at 50$^{th}$ SMW), painted bug (13.37 nymphs+adults plant$^{-1}$ at 50$^{th}$ SMW), mustard sawfly (12 larvae plant$^{-1}$ at 48$^{th}$ SMW), flea beetle (12.45 grubs+adults plant$^{-1}$ at 50$^{th}$ SMW), diamondback moth (1.3 larvae plant$^{-1}$ at 52$^{nd}$ SMW), leaf webber (6.45 larvae plant$^{-1}$ at 51$^{st}$ SMW), Bihar hairy caterpillar (29.3 larvae plant$^{-1}$at 50$^{th}$ SMW) and tobacco caterpillar (8.9 larvae plant$^{-1}$ at 49$^{th}$ SMW. Similarly, the highest peak population of pests recorded for 2022/23 were: mustard aphid (3.82 A.Iplant$^{-1}$ at 51$^{st}$ SMW), whitefly (23.8 whiteflies plant$^{-1}$ at 50$^{th}$ SMW), painted bug (13.7nymphs+adults plant$^{-1}$ at 51$^{st}$ SMW), mustard sawfly (15 larvae plant$^{-1}$ at 48$^{th}$SMW), flea beetle (13.45grubs+adults plant$^{-1}$ at 50$^{th}$ SMW), diamondback moth (1.2 larvae plant$^{-1}$ at 47$^{th}$ SMW), leaf webber (5.45 larvae plant$^{-1}$ at 51$^{st}$ SMW), which coincided the abundance of natural enemies namely, coccinellid predators, syrphid fly and spider between 50$^{th}$ to 52$^{nd}$ SMW of the experimental year for both seasons.

The correlation of insect pest density with weather parameters (*Rabi*, 2021/22) showed negative correlations with $T_{max}$ (mustard aphid, painted bug, flea beetle, leaf webber, diamondback moth, Bihar hairy caterpillar), $T_{min}$ (all pests), rainfall (mustard aphid, whitefly, mustard sawfly, flea beetle, tobacco caterpillar), RH% at 7 hours (all pests), and RH% at 14 hours (mustard aphid, whitefly, painted bug, leaf webber, diamondback moth, Bihar hairy caterpillar).For natural enemies, $T_{max}$, $T_{min}$, RH% at 7 hours, RH% at 14 hours, and wind velocity had negative effects on their population, while rainfall had a positive influence.However, in *Rabi*2022/23, $T_{max,}$ $T_{min,}$ and RH% at 14 hours negatively influenced the pest population mostly except for wind velocity and RH% at 7 hours. For predators, wind velocity showed

positive correlation with its' population.

**Keywords:**Seasonal incidence, rapeseed-toria, insect pests, natural enemies, meteorological parameters.

## 1. INTRODUCTION

Toria (*Brassica rapa*Linnaeus, 2n (2x) = 20) is a significant oilseed crop in India grown during the *Rabi* season. Belonging to the Brassicaceae family. It is commonly known as sarson or lahi and has its origin in South-East Asia through the crossing of *Brassica nigra*and *B. campestris*[1][2]. Rapeseed-mustard, including toria, encompasses eight different species and is cultivated in 53 countries worldwide. The place of origin of rapeseed is Eastern Afghanistan and adjoining part of India and Pakistan [3]. In India, rapeseed-mustard contributes nearly 80% of the total *Rabi* oilseed production and is widely grown in various states.[4]
However, despite the availability of good production technology, the crop faces challenges due to various biotic and abiotic factors. Insect pests are a major constraint, causing significant yield losses. Mustard aphid, mustard sawfly, leaf miner, painted bug, flea beetle, diamondback moth, cabbage aphid and green peach aphid are the insects infesting the crop in India [5].To manage these pests, the primary priority is to understand the pest ecology and pest cycle along with the susceptible crop growth stages. Predatory fauna like coccinellid beetles[6], etc play a vital role in crop ecosystem. In the context of Odisha's north-western plateau region, limited research has been conducted on insect-pest complex of toria. Therefore, an experiment was carried out to study the seasonal incidence of important insect pests and their natural enemies ontoriawithmeteorological parameterslike maximum and minimum temperature, morning and evening relative humidity, rainfall on development and survival of the insect pests and natural enemies was studied.By focusing on sustainable practices, farmers can improve toria production and reduce yield losses caused by insect pests.

## 2. MATERIALS AND METHODS

The field experiment was conducted for two consecutive *Rabi*seasons ofyears 2021/22 and 2022/23 at the Experimental Farm, College of Horticulture, Odisha University of Agriculture and Technology, Chiplima, Odisha. "Sushree" variety was selected and sown in an area of 200 $m^2$ with a spacing of 30 cm row to row and 10 cm plant to plant. All recommended agronomical practices were followed to raise the crop. Observations on the incidence of major insect-pestsand predators were counted from 10 plants

randomly, recorded at weekly intervals starting from two weeks after sowing till the crop maturity.
Weekly weather data was obtained from the regional research and technology transfer station (RRTTS), Chiplima, Odisha. The correlation coefficients between the incidence of insect pests/ predators and weather factors*i.e.,* $T_{max}$, $T_{min}$, rainfall, RH% (7 hr.), RH%(14hr.), wind velocitywas calculated.

### 2.1 Observations on important insect pests

#### 2.1.1 Mustard Aphid

Ten number of plants were selected randomly and from each plant, aphid population was worked out in terms of aphid index (0-4 scale) based on method suggested by
Butani and Bharodia[7], which has been presented below in list 1.

#### 2.1.2 Other important insect pests and natural enemies.

Ten numbers of plants were selected randomly and from each plant average number of insects per plant *i.e.,*whitefly (No. of adultsplant$^{-1}$), painted bug (No. of nymphs+adultsplant$^{-1}$), mustard sawfly (No. of larvaeplant$^{-1}$), flea beetle (No. of grubs+adultsplant$^{-1}$t), Leaf webber (No. of larvaeplant$^{-1}$), diamondback moth (No. of larvaeplant$^{-1}$), tobacco caterpillar (No. of larvaeplant$^{-1}$), Bihar hairy caterpillar (No. of larvaeplant$^{-1}$), coccinellid predators (No. of grubs+adultsplant$^{-1}$), syrphid fly (No. of maggotsplant$^{-1}$) and Spider (No. of adultsplant$^{-1}$) was calculated.

**List 1- Aphid index infestation scale**

| **Index scale** | **Aphidinfestation** |
|---|---|
| 0 | Plantfreefromaphidinfection |
| 1 | Aphidspresentbut coloniesare notbuiltup |
| 2 | Smallcoloniesofaphidpresent |
| 3 | Largecoloniesofaphidspresentontenderplantparts(Countsarepossible) |
| 4 | Entireplantscovered byaphidandcountsimpossible |

The average aphid index worked out by adopting the following formula:
Average Aphid Index (A.I) = 0N + 1N + 2N + 3N + 4N / Total no of plants observed.
Where;
0, 1, 2, 3, 4 are aphid index
N = Number of plants showing respective aphid index

## 3. RESULTS AND DISCUSSION

Nine insect pests namely mustard aphid (*Lipaphiserysimi*Kaltenbach), whitefly (*Bemisiatabaci*Gennadius), painted bug (*Bagradahilaris*Kirkaldy), mustard sawfly (*Athalia lugensproxima*Kluger), flea beetle (*Phyllotretacruciferae*Goeze, *Monoleptasignata*Olivier), leaf webber (*Crocidolomiabinotalis*Zeller), diamondback moth (*Plutellaxylostella*Linnaeus), tobacco caterpillar(*Spodoptera litura*Fabricius), Bihar hairy caterpillar (*Spilarctiaobliqua*Walker) were observed at different stages of the crop growth. Among natural enemies of the pests observed were, coccinellid predators (*Coccinella transversalis, Menochilussexmaculatus*Fabriciusand*Coccinella californica* Mannerheim), syrphid fly (*Episyrphusbalteatus)* and spider. There was significant difference in the occurrence of insect pests during the two observed seasons *i.e., Rabi* of 2021/22 and 2022/23.

### 3.1 Seasonal incidence of insect pests and predators ontoriaduring *Rabi* of2021/22 and *Rabi* 2022/23

#### 3.1.1. Mustard Aphid

The observed data (Tables 1 and 2) clearly indicated that the overall population of mustard aphid persisted throughout the growing season of toria specifically during vegetative maturity stage and it lasted up to the siliqua harvest stage *i.e.,*45$^{th}$ SMWto 2$^{nd}$ SMW (of next year) for both seasons. The peak population of the pest was 3.7 A.Iplant$^{-1}$(50$^{th}$ SMW) and 3.82 A.Iplant$^{-1}$ (51$^{st}$ SMW) during *Rabi* of 2021/22 and 2022/23, respectively. Earlier to this, Nayak [8] and other workers (Mandawi*et al.* [9], Pradhan *et al.* [10], Yadav *et al.*[11]) reported similar observations in their experiments.

#### 3.1.2. Whitefly

It was evident from the recorded data(Tables 1 and 2) that pest density of whitefly in the growing period of toria persisted throughout the vegetative maturity stage and continued up to siliqua harvest stage *i.e.,* 45$^{th}$ SMW to 1$^{st}$SMW (of next year) for the*Rabi*seasons. The pest density peaked at 25.9 adultsplant$^{-1}$ (50$^{th}$ SMW) and 23.8 adultsplant$^{-1}$ (50$^{th}$ SMW) during *Rabi* of2021/22 and 2022/23, respectively. Syed *et al.*[12] in his experiment found almost similar results.

#### 3.1.3. Painted bug

The pest infestation initiated at the flowering stage of the crop *i.e.,* 46$^{th}$ SMW. The peak painted bug population in toria was observed with 13.37nymphs+adultsplant$^{-1}$(50$^{th}$ SMW) in *Rabi*of 2021/22 and 13.7

nymphs+adultsplant$^{-1}$(51$^{st}$ SMW) in*Rabi*of 2022/23. However, varied but similar results were also observed in the field studies undertaken by Divya *et al.* [13], where the data revealed that incidence of painted bug started in 3$^{rd}$ week of December in both years and attained first peak during the 1$^{st}$ week of January(Tables 1 and 2).

### 3.1.4. Mustard sawfly

The occurrence of mustard sawfly on toriaduring *Rabi*of 2021/22,was observed initially at 45$^{th}$SMW,which coincided the vegetative maturity stage(Tables 1 and 2). The population attained peak (12.0 larvaeplant$^{-1}$) at 48$^{th}$ SMW.Similar pest density results were also confirmed in an experiment conducted by Pradhan *et al.*[14] as data revealed occurrence of sawfly during 51$^{st}$ SMW *i.e.,* 3$^{rd}$ week of December.

Conversely, the population density of the said pest during *Rabi*of 2022/23, was surprisingly different from the previous season observation(Tables 1 and 2).The pest began its' infestations quite earlier *i.e.,* 44$^{th}$ SMW (almost 2 weeks after sowing). The peak population was 15.00 larvae/plant at 48$^{th}$ SMW and the infestation lasted up to siliqua harvest stage of the crop.These results confirmed to the findings of Pal *et al.* [15]where, incidence of mustard sawfly on varieties *Urvashi,* GSC6, BSH1, YST151, T27, DRMR IJ-31 were recorded in a range of 0 to 2.6 larvae/plant in 45$^{th}$ standard meteorological week (SMW) and found till 48$^{th}$ SMW.

### 3.1.5 Flea beetle

The results on flea beetle population were apparent on infestation(Tables 1 and 2)that started with 8.34 grubs+adultsplant$^{-1}$ from 46$^{th}$ SMW (flowering stage) and continued up to 2 SMW (2$^{nd}$ week of January). The peak level of population was observed at 50$^{th}$ SMW (12.45 grubs+adultsplant$^{-1}$ in *Rabi*of 2021/22 and 13.45 grubs+adultsplant$^{-1}$ in *Rabi*of 2022/23). Our findings are much similar with that of Pradhan *et al.* [10], where flea beetle was observed during 51$^{st}$ SMW *i.e.,* 3$^{rd}$ week of December 2018 and active till 9$^{th}$ SMW *i.e.,* 1$^{st}$ week of March 2019 and maximum population (1.60plant$^{-1}$) was observed during the 6$^{th}$ SMW.

### 3.1.6 Leaf webber

Current findings (Table 1 and 2) revealed that the leaf webber incidence was observed first at 48$^{th}$ SMW *i.e.,* siliqua development of the crop(Tables 1 and 2). Its peak level was seen as 6.45 larvaeplant$^{-1}$ at 50$^{th}$ SMW in2021/22.However, in *Rabi* of 2022/23, the larval population was highest and consistent throughout the 51$^{st}$-52$^{nd}$ SMW (5.44-5.45 larvaplant$^{-1}$).Thereafter, the pest population decreased and disappeared at the time of

harvesting. Similar results of pest density had been reported by Pawar *et al.*[16], wherelarval population of leaf webber on mustard started to build up after 2nd week of sowing *i.e.,* 3rd week of November (1.60 larvaeplant$^{-1}$) and ranged between 1.10 to 9.20 larvaeplant$^{-1}$.

### 3.1.7 Diamondback moth

The initial population of the pest(Tables1 and 2)started at 46th SMW *i.e.,* flowering stage. The highest peak of incidence was 1.3 larvae/plant at 52nd SMW (siliqua development stage) during *Rabi* 2021-22.Conversely the following season (*Rabi*of 2022/23), insect's peak population (1.2 larvaeplant$^{-1}$) was observed at 47th SMW *i.e.,* flowering stage. This corroborates with the findings of Shaila *et al.* [17],who reported first appearance of diamondback moth was during vegetative stage of the crop and the peak incidence of *Plutellaxylostella*(12.31 larvaeplant$^{-1}$) was observed at 49th SMW *i.e.,* during 1st week of December, later the population declined gradually.

### 3.1.8 Bihar hairy caterpillar

The first appearance of the pest(Tables 1 and 2) on toria was at 48th SMW*i.e.,* flowering stage. Its peak population was 29.3 larvaeplant$^{-1}$ at 50th SMW. Kashyap *et al*. [18] concluded the similar results on the incidence of Bihar hairy caterpillar that started from 2nd week of December (50th SMW) with 0.02 larvae per plant and population ranged from 0.02 to 0.12 larvae plant$^{-1}$.However, during*Rabi*of 2022l23, there was no incidence of the said pest throughout the crop season.

### 3.1.9 Tobacco caterpillar

The polyphagous pest, tobacco caterpillar(Tables 1 and 2) during*Rabi*of 2021/22appeared at the vegetative maturity stage*i.e.,* 45th SMW (5.6 larvaeplant$^{-1}$)and attained its' peak population (8.9 larvaeplant$^{-1}$) at49th SMW, *i.e.,* siliqua development stage. Likewise,resemblingoutcomeswere reported by Kumar *et al*. [19]. In *Rabi*of2022/23, there was no incidence of pests throughout the cropping season.

### 3.1.10 Coccinellid predators

The aphid appeared at a very early stage of the crop, which was synchronized with the activities of predatory coccinellid beetles (Tables1 and 2)*i.e.,*44thSMW. The peak population of the predator during *Rabi*of 2021/22 was 5.34 grubs+adultsplant$^{-1}$ at 3rd SMW (siliqua harvest stage). In season of 2022/23, the predator population was highest at 1st SMW (5.11 grubs+adultsplant$^{-1}$). The observation is much identical to Shaila *et al.,* [17], who reported that the activity of coccinellids initiated from 1st week of

January (0.22 beetle/plant) and reached its peak (1.20 beetle$plant^{-1}$) in 2nd SMW.

### 3.1.11 Syrphid fly

The syrphid fly appeared during 45th SMW (1.01 maggot$plant^{-1}$), *i.e.,* flowering stageand population was higher (2.09 maggots/plant) at 2nd SMW of *Rabi*of 2021/22(Tables 1 and 2).Similarly, peak population of maggots in the next observed season (*Rabi*of 2022.23) was 2.08$plant^{-1}$. These results are supported by Mishra *et al.* [20], who stated that the predator appeared in the 2nd week of January and its peak population was (13 larvae5$plants^{-1}$) during 4th week of January.

### 3.1.12 Spider

The spider appeared during 45th SMW (0.08 spider$plant^{-1}$), and population was highest (0.37 spider$plant^{-1}$) at 3rd SMW i.e., siliqua harvest stage(Tables 1 and 2). Following the same trend of pest population in the two successive seasons.

**Table 1: Seasonal incidence of insect pests and predators on toria under field conditions during *Rabi*,2021/22**

| WAS | SMW | Aphid Index (0-4 Scale) | Mean No. of insect pests (adults/nymphs/grubs/larvae/plant) | | | | | | | | Mean No. of predators (adults/maggots/grubs/plant) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mustard Aphid | White fly | Painted Bug | Mustard sawfly | Flea Beetle | Diamond Back Moth | Leaf Webber | BHC | TC | Coccinellid | Syrphid fly | Spider |
| 2 | 44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.09 | 0 | 0 |
| 3 | 45 | 0.01 | 0.05 | 0 | 0.02 | 0 | 0 | 0 | 0 | 5.6 | 2.09 | 0 | 0.08 |
| 4 | 46 | 2.01 | 18.53 | 5.77 | 8.3 | 8.34 | 0.35 | 0 | 0 | 5.78 | 4.2 | 1.01 | 0.09 |
| 5 | 47 | 3.34 | 23.3 | 8.61 | 9.71 | 10.0 | 0.90 | 0 | 0 | 6.77 | 4.38 | 1.03 | 0.09 |
| 6 | 48 | 2.94 | 21.8 | 8.92 | 12.0 | 11.03 | 0.91 | 3.24 | 10.3 | 6.9 | 4.78 | 1.02 | 0.13 |
| 7 | 49 | 2.9 | 24.4 | 9.11 | 11.37 | 11.24 | 0.89 | 5.26 | 24.9 | 8.9 | 4.56 | 1.01 | 0.19 |
| 8 | 50 | 3.7 | 25.9 | 13.37 | 10.5 | 12.45 | 0.98 | 6.33 | 29.3 | 7.96 | 4.77 | 1.02 | 0.14 |
| 9 | 51 | 3.5 | 24.53 | 12.81 | 8.45 | 11.23 | 1.0 | 6.45 | 28.5 | 7.56 | 4.67 | 1.24 | 0.09 |
| 10 | 52 | 2.4 | 10.10 | 10.5 | 3.05 | 7.56 | 1.3 | 5.7 | 24.9 | 5.23 | 4.75 | 1.58 | 0.18 |
| 11 | 1 | 1.5 | 5.3 | 6.3 | 0 | 3.2 | 0.5 | 4.3 | 10.0 | 1.22 | 5.11 | 1.19 | 0.12 |
| 12 | 2 | 1.01 | 0 | 2.21 | 0 | 2.45 | 0 | 0 | 0 | 0 | 5.21 | 2.09 | 0.25 |
| 13 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5.34 | 1.95 | 0.37 |

** WAS – Weeks after sowing,* *SMW- Standard meteorological weeks,*

*BHC -Bihar hairy caterpillarand*

*TC- Tobacco caterpillar.*

**Table 2: Seasonal incidence of insect pests and predators on toria under field conditions during *Rabi*, 2022/23**

| WAS | SMW | Aphid Index (0-4 Scale) | Mean No. of insect pests (adults/nymphs/grubs/larvae/plant) | | | | | | Mean No. of predators (adults/maggots/grubs/plant) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mustard aphid | White fly | Painted bug | Mustard sawfly | Flea beetle | Diamond back moth | Leaf Webber | Coccinellid | Syrphid fly | Spider |
| 2 | 44 | 0 | 0 | 0 | 0.9 | 0 | 0 | 0 | 0.5 | 0 | 0 |
| 3 | 45 | 0.09 | 0.05 | 0 | 2.8 | 0 | 0 | 0 | 2.0 | 0 | 0.09 |
| 4 | 46 | 2.50 | 15.5 | 4.9 | 5.2 | 6.64 | 0.45 | 0 | 4.35 | 1.01 | 0.08 |
| 5 | 47 | 3.39 | 20.3 | 7.91 | 8.41 | 10.5 | 1.2 | 0 | 4.42 | 1.5 | 0.09 |
| 6 | 48 | 3.57 | 21.0 | 8.05 | 15.0 | 11.03 | 0.93 | 3.54 | 4.54 | 1.92 | 0.5 |
| 7 | 49 | 3.01 | 20.4 | 9.2 | 12.07 | 11.5 | 0.89 | 4.29 | 4.66 | 1.88 | 0.29 |
| 8 | 50 | 2.9 | 23.8 | 12.57 | 11.5 | 13.45 | 0.97 | 5.44 | 4.89 | 1.56 | 0.24 |
| 9 | 51 | 3.82 | 21.57 | 13.7 | 6.47 | 11.23 | 1.0 | 5.45 | 4.63 | 1.24 | 0.19 |
| 10 | 52 | 2.9 | 12.13 | 11.5 | 2.35 | 9.56 | 1.0 | 3.43 | 4.75 | 1.28 | 0.18 |
| 11 | 1 | 1.5 | 8.3 | 7.5 | 0.8 | 5.6 | 0 | 0 | 5.01 | 1.19 | 0.22 |
| 12 | 2 | 1.0 | 0 | 3.01 | 0.2 | 3.45 | 0 | 0 | 5.11 | 2.08 | 0.30 |
| 13 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5.0 | 1.87 | 0.35 |

** WAS – Weeks after sowing, SMW- Standard Meteorological weeks,*
*BHC -Bihar hairy caterpillar and TC- Tobacco caterpillar.*

**Table 3: Correlation coefficient (r) of different weather parameters with insect pests/predators on toria during *Rabi*, 2021/22**

| Insect pests/ predators | Temperature ($^0$C) | | Rainfall | Relative Humidity (%)after (hours) | | Wind velocity |
|---|---|---|---|---|---|---|
| | Maximum | Minimum | | 7 | 14 | |
| Mustard aphid | -0.16289 | -0.31019 | -0.01596 | -0.14107 | -0.04429 | 0.34454 |
| Whitefly | 0.05017 | -0.17701 | -0.21794 | -0.19144 | -0.00796 | 0.41522 |
| Painted bug | -0.25794 | -0.46406 | 0.05909 | -0.15568 | -0.13125 | 0.24994 |
| Mustard sawfly | 0.08214 | -0.05556 | -0.22966 | -0.15782 | 0.06633 | 0.52870 |
| Flea beetle | -0.12572 | -0.23720 | -0.03698 | -0.12362 | 0.02535 | 0.45989 |
| Leaf Webber | -0.40514 | -0.66241* | 0.04751 | -0.17188 | -0.25636 | 0.00891 |
| Bihar hairy caterpillar | -0.40034 | -0.60401* | 0.07344 | -0.21424 | -0.27809 | 0.10778 |
| Diamondback moth | -0.22520 | -0.35913 | 0.16574 | -0.01969 | -0.07002 | 0.31657 |
| Tobacco caterpillar | 0.12108 | -0.02447 | -0.16841 | -0.12467 | 0.02186 | 0.57265* |
| Coccinellid | -0.69326* | -0.58913* | 0.244511 | -0.05138 | 0.031869 | -0.20009 |
| Syrphid fly | -0.83003** | -0.52899 | 0.490033 | -0.02627 | -0.00883 | -0.28531 |
| Spider | -0.66928* | -0.4096 | 0.258023 | -0.07714 | -0.07401 | -0.37037 |

**Significant at 5% level of significance ** Highly significant at 1% level of significance.*

**Table 4: Correlation coefficient (r) of different weather parameters with insect pests/predators on toria during *Rabi*, 2022/23**

| Insect pests/ predators | Temperature ($^0$C) | | Rainfall | Relative humidity (%)after (hours) | | Wind velocity |
|---|---|---|---|---|---|---|
| | Maximum | Minimum | | 7 | 14 | |
| **Mustard aphid** | -0.19528 | -0.63327* | 0 | -0.09928 | -0.12771 | 0.573889 |
| **Whitefly** | -0.21876 | -0.42298 | 0 | 0.050827 | -0.08357 | 0.629266* |
| **Painted bug** | -0.29252 | -0.64774* | 0 | 0.044286 | -0.13405 | 0.630329* |
| **Mustard sawfly** | -0.11928 | -0.16236 | 0 | 0.053038 | -0.0842 | 0.37711 |
| **Flea beetle** | -0.24274 | -0.5584 | 0 | -0.05518 | -0.12525 | 0.655065* |
| **Leaf Webber** | -0.20311 | -0.45288 | 0 | 0.208612 | -0.2246 | 0.325065 |
| **Diamondback moth** | 0.033427 | -0.42052 | 0 | 0.002097 | 0.086534 | 0.481738 |
| **Coccinellid** | -0.56536 | -0.66065* | 0 | -0.21439 | -0.29433 | 0.45103 |
| **Syrphid fly** | -0.53901 | -0.58786 | 0 | -0.39273 | -0.41366 | 0.42477 |
| **Spider** | -0.51916 | -0.35057 | 0 | -0.08579 | -0.34291 | 0.053812 |

**Significant at 5% level of significance ** Highly significant at 1% level of significance.*

### 3.2 Correlation of insect-pest and predator population with weather parameters during *Rabi*of2021/22 and 2022/23

The results from the correlation of insect pest density with various weather parameters in *Rabi*of 2021/22 (Table 3) concluded that positive correlation was established by maximum temperature (for whitefly, mustard sawfly, and tobacco caterpillar), rainfall (for painted bug, leaf Webber, diamondback moth, Bihar hairy caterpillar), wind velocity (for all insect pest), RH% at 14 hours (for mustard sawfly, flea beetle and tobacco caterpillar).However, there was a negative effect on the abundance of various insect pests by maximum temperature (for mustard aphid, painted bug, flea beetle, leaf Webber, diamondback moth, Bihar hairy caterpillar), minimum temperature (for all insect pests), rainfall (for mustard aphid, whitefly, mustard sawfly, flea beetle and tobacco caterpillar), RH% at 7 hours (for all insect pests) and RH% at 14 hours (mustard aphid, whitefly, painted bug, mustard sawfly, leaf Webber, diamondback moth and Bihar hairy caterpillar).

The correlation of natural enemies with various weather parameters concluded that maximum temperature, minimum temperature, RH% at 7 hours, RH% at 14 hours and wind velocity negatively influenced the mean population however, rainfall had a positive effect on the natural enemies'population.

The relations between insect pest population and weather parameters in *Rabi*of 2022/23 (Table 4) showed positive correlation with maximum temperature (diamondback moth), wind velocity (all pests), and RH% at 7 hours (whitefly, painted bug, mustard sawfly, leaf Webber, diamondback moth). Conversely, negative correlations were found with maximum temperature (mustard aphid, whitefly, painted bug, mustard, flea beetle, leaf Webber), minimum temperature (all pests), rainfall, RH% at 14 hours (mustard aphid, whitefly, painted bug, mustard sawfly, flea beetle, leaf Webber) and no significant relationship with rainfall.

For natural enemies, maximum temperature, minimum temperature, RH% at 7 hours, RH% at 14 hours, and wind velocity had negative effects on their population, while rainfall had a positive influence on the same. Theseresults are agreement with the findings of Patel *et al*. [21], Divya *et al.* [13], Lal *et al.* [22], Patel *et al*. [23]. Kashyap *et al*. [18], and Mishra *et al.* [20].

## 4. CONCLUSION

From the present study it can be concluded that the period between 3$^{rd}$ week of November to last week of December of 2021 and 2022 of the cropping seasons, was the most suitable period for abundance of almost all the major insect pests of toria. Whereas, in the prevailing condition of weather

parameters *viz.,* maximum temperature, minimum temperature and RH at 7 hours and 14 hours, the pest density can be declined to much extent.

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